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Results of data conversions for American plaice in Div. 2J and 3K from comparative fishing trials between the Engel otter trawl and the Campelen 1800 shrimp trawl

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Abstract

In the fall of 1995 the Department of Fisheries and Oceans changed its survey trawl from an Engel 145 high rise otter trawl with bobbin gear to a Campelen 1800 shrimp trawl using rockhopper gear. In the 2+3K area there was also a change in vessel from the *Gadus Atlantica* to the *Teleost*. In order to establish a link between the two sets of survey data, comparative fishing trials were conducted in 1995 to develop length based conversion factors between the two fishing gear/vessel combinations. The application of the conversion factors results in a large increase in the abundance of small sizes. When age length keys are applied to the converted data the age compositions are shifted towards younger fish with large increases in the numbers of fish less than age 7 or 8. Trends in total abundance are the same for the original and converted data, with abundance levels being greater for the converted series. The same result is clear for biomass, with both series showing large declines over the time period but with the level of biomass being greater for the converted series.

Résumé

À l'automne 1995, le ministère des Pêches et des Océans a substitué un chalut à crevettes Campelen 1800 à faux-bourrelet sauterelle au chalut à panneaux Engel 145 à remontée élevée, muni d'un bourrelet de diabolos, pour effectuer les relevés. On a aussi substitué le *Teleost* au *Gadus Atlantica* pour effectuer les relevés dans les sous-zones 2+3K. Afin d'établir un lien entre les séries de données de relevé, des essais de pêche comparatifs ont été menés en 1995 en vue de recueillir des données pour calculer des facteurs de conversion, basés sur la longueur, entre les deux combinaisons engin de pêche/bateau. L'application des facteurs de conversion a résulté en une forte augmentation de l'abondance des poissons de petite taille. Lorsque des clés de l'âge selon la longueur ont été appliquées aux données converties, les compositions selon l'âge ont été décalées en faveur des jeunes poissons, le nombre d'individus de moins de 7 à 8 ans affichant de fortes augmentations. Les tendances de l'abondance totale se ressemblaient dans les données originales et les données converties, les niveaux étant plus élevés dans le cas de la série de données converties. Le même résultat a été obtenu dans le cas de la biomasse, les deux séries affichant des baisses marquées pendant la période visée, bien que le niveau était plus élevé dans la série de données converti

Introduction

In 1995 the research vessel *Teleost* (TEL) replaced the *Gadus Atlantica* (GA) in the Department of Fisheries and Oceans fleet. At the same time the net used in the surveys was changed from the Engel bottom otter trawl with bobbin foot gear to the Campelen 1800 shrimp trawl using rockhopper foot gear. In order to establish a link between the two sets of survey data, comparative fishing trials were conducted in 1995 to develop conversion factors between the two fishing gear/vessel combinations. The trials were conducted between the GA towing the Engel gear and the TEL towing the Campelen gear.

A thorough description of the experimental design and analytical methodology can be found in Warren (1996) and thus will not be described in detail here. The conversion factors derived are dependent on fish length, given the different selectivities of the 2 trawl/vessel combinations involved. The purpose of this paper is to illustrate the results of the conversion factors and the impact on length and age distribution, as well as on trends in stock size of American plaice in Divs. 2J and 3K.

Materials and Methods

Length frequencies, standardized for towing distance, for American plaice in NAFO Divs. 2J and 3K were converted from GA Engel trawl catches to TEL Campelen 1800 trawl catch equivalents for the fall surveys during the years 1978 to 1994. All subsequent surveys were actually carried out using the Campelen 1800 trawl. The results of the data conversion between the *Wilfred Templeman* (WT) towing the Campelen 1800 gear and its sister ship the *Alfred Needler* (AN) towing the Engel gear were also examined (Morgan et al. 1998).

Results and Discussion

Development of conversion factors

The data gathered during the experiment are so scattered above 40 cm, with a wide range of ratios, sometimes at adjacent length groups, that the equation in this range can not be considered reliable (Fig. 1). There is a similar problem in the WT-AN experiment as well (Morgan et al. 1998). Beyond 40 cm the fitted curve quickly drops below the 1:1 line. However, there are twice as many residuals above the line as there are below the line. The mean ratio in the 41-61 cm range is 1.54 and the ratio of the sums is 0.82. These results, in combination with the results of the WT-AN experiment led us to conclude that the conversions from both experiments should be leveled off at 40 cm at 1:1 (Morgan et al. 1998).

At the lower end of the curve the equation from the TEL-GA rises extremely steeply (Warren, 1996). This is based on a very low sample size (only 56 fish caught by the Engel below 16 cm). Sample size in the 16-17 cm length category is larger (103 fish caught by the Engel) but similar to the last length group that was not included in the WT-AN conversion (Morgan et al. 1998). Sample size in the 18-19 cm length category is somewhat greater (141 fish caught by the Engel) and it was decided that this would be the smallest size category to which the conversion equation

would be applied. However, fish below this size should not be ignored as they were routinely caught by the Engel trawl in this survey. Also, fish as old as at least age 5 will be affected by what is done to the fish less than 18 cm . We feel that it is better to make a conversion (albeit an underestimate) than to not convert these length groups. We therefore decided to use a conversion factor of 16.17, which is the conversion factor calculated for the mid-point of the 16-17 cm length group, to convert all length groups less than 18 cm.

The conversion used was as follows (for fish of length X):

for 18 cm $\leq X \leq$ 39 cm use the equation of Warren (1996) to calculate the conversion factor:

$cf = \exp(11.740705 + 0.010335X - 3.2561\ln(X))$

for $X \leq 17$ $cf = 16.17$
for $X \geq 40$ $cf = 1.0$

Application of conversion factors

After the length frequencies were converted to Campelen trawl catch equivalents they were used in the standard stratified analysis program, along with annual age-length keys collected for each sex. This provided the total numbers of American plaice caught, by length and age group, per standard Campelen set (0.8 nautical mile tow distance in 15 minutes with a wing spread of 16.84 m or 55.25 ft). Separate keys for each division were used except in 1978-1980 when combined 2J3K keys were used. Data for 1989 and 1990 did not include sets conducted under the two phase sampling scheme. Some changes have been made in the original Engel data presented in Brodie et al (1995). In that paper there were errors in the mean numbers per tow at age in 1989 and 1993 and these have been corrected here. In addition, that paper used a combined Div. 2J3K age length key in the production of mean numbers per tow at age for 1992. This has been reanalysed here using separate keys. From 1978-1987 the original Engel mean numbers per tow at age were produced using selected strata. The conversions presented here for mean numbers per tow at age use all strata as do the abundances at length for both Engel and converted data.

Abundances at length for the original Engel data and converted to Campelen equivalents are given in Tables 1 and 2 and in Figures 2 and 3. The large increase in abundance at small sizes is clear. For fish of 40 cm and greater the increase is the difference in the swept area of the two trawls, with the converted abundances being 1.83 times the original. When age length keys are applied to the converted data the age compositions are shifted towards younger fish with large increases in the numbers of fish less than age 7 or 8 (Tables 3 and 4, Figures 4 and 5).

Biomass estimates for the converted data were calculated by applying length weight relationships derived for each Division and sex to the abundance at length data. From 1990 to 1994, annual relationships could be derived. From 1978-1989 combined 1990-1993 relationships were used as annual data were not available. The parameter estimates for the length weight relationships are given in Table 5.

Trends in abundance are the same for the original and converted data, with abundance levels being greater for the converted series (Fig. 6). The same result is clear for biomass, with both series showing large declines over the time period but with the level of biomass being greater for the converted series (Fig. 7).

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Table 1a. Abundance (millions) at length of American plaice from fall surveys in Div. 2J. Data in original Engel units.

Length/Year	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10.5	0	0	0	0	0	0	0	0.03	0	0.02	0	0	0	0	0	0	0
12.5	0	0	0	0	0	0.02	0	0.03	0	0.01	0	0.03	0	0	0	0	0
14.5	0.03	0.03	0	0.02	0.05	0.11	0.02	0.04	0.04	0.03	0	0.04	0.03	0	0	0	0.03
16.5	0.16	0.08	0	0.02	0.13	0.07	0.03	0.03	0.22	0.16	0.02	0.06	0.05	0.04	0.04	0	0.08
18.5	1.03	0.59	0.2	0.06	0.15	0.12	0.27	0.21	0.35	0.28	0.1	0.12	0.17	0.12	0.07	0.14	0.15
20.5	2	1.83	0.27	0.19	0.52	0.25	0.29	0.44	0.17	0.35	0.46	0.62	0.5	0.32	0.38	0.34	0.60
22.5	5.68	4.56	1.04	0.52	1.67	0.64	0.84	0.97	0.69	0.43	0.41	1.42	1.06	0.7	0.68	0.58	1.05
24.5	9.21	9.03	4.58	2.26	4.75	1.97	1.55	2.75	1.59	0.84	1.07	2.62	1.98	1.21	0.97	1.20	0.90
26.5	14.97	10.56	8.96	5.59	10.88	5.45	2.69	4.45	3.3	1.92	2.12	3.98	2.92	2.18	1.02	0.96	0.76
28.5	16.51	10.84	13.65	9.9	19.4	11.66	6.14	6.75	4.16	3.35	3.04	5.11	4.06	2.29	1.26	1.00	1.25
30.5	20.17	11.79	16.69	15.12	27.2	18.02	9.95	10.4	6.66	3.82	3.77	5.97	4.89	2.45	1.32	1.05	0.92
32.5	13.12	11.37	15.89	15.17	30.4	22.12	12.85	11.71	8.11	4.47	5.01	7.03	4.99	2.36	1.17	1.05	0.86
34.5	11.98	8.49	14.41	16.51	25.99	23.01	12.73	12	8.97	4.46	6.63	7.88	4.23	2.7	0.84	0.80	0.41
36.5	9.57	6.08	11.7	14.66	22.04	19.55	12.92	10.47	8.33	4.35	7.06	6.42	4.65	1.92	0.49	0.40	0.22
38.5	7.46	5.48	7	11.9	16.79	18.54	12.06	8.9	7.67	4.14	5.59	5.11	3.22	1.24	0.33	0.28	0.27
40.5	5.46	2.96	6.7	8.45	12.04	16.8	9.7	7.56	6.96	3.83	5.36	4.89	2.56	0.85	0.24	0.23	0.06
42.5	5.37	3.13	4.72	6.72	7.66	12.11	6.86	5.53	5.01	3.26	5.73	3.91	1.96	0.63	0.12	0.19	0.02
44.5	3.74	2.19	3.65	4.79	5.27	8.67	4.5	3.76	3.72	2.96	4	3.17	1.5	0.45	0.14	0.09	0.04
46.5	3.63	2.23	3.1	4	4.44	6.95	3.68	2.21	1.99	1.94	2.78	2.06	0.84	0.26	0.12	0.04	0.02
48.5	2.69	1.48	3.14	2.91	3.56	5.2	2.03	1.38	1.16	1.03	1.17	1.43	0.41	0.15	0.06	0	0
50.5	2.21	1.55	2.35	1.79	2.38	2.33	1.14	0.7	0.9	0.68	0.66	0.4	0.3	0.04	0.02	0	0
52.5	1.09	0.91	1.35	1.61	1.41	1.83	1.18	0.44	0.37	0.35	0.33	0.15	0.07	0.04	0.01	0	0
54.5	0.79	0.61	0.55	0.55	0.77	1.02	0.44	0.15	0.27	0.09	0.08	0.11	0	0.02	0	0	0
56.5	0.58	0.11	0.23	0.32	0.27	0.26	0.19	0.03	0.17	0.03	0.03	0.03	0.03	0	0	0	0
58.5	0.14	0.03	0.24	0.03	0.15	0.07	0.05	0.03	0.02	0.03	0	0.06	0.02	0	0	0	0
60.5	0.03	0	0.03	0.05	0	0.01	0	0	0	0	0	0	0	0	0	0	0
62.5	0	0	0.04	0	0.02	0	0	0	0	0	0	0	0	0	0	0	0

Table 1b. Abundance (millions) at length of American plaice from fall surveys in Div. 3K. Data in original Engel units.

Length/Year	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8.5	0	0.02	0	0	0	0	0.01	0.19	0.03	0.02	0	0.03	0.02	0	0	0	0.04
10.5	0	0	0	0	0	0.01	0	0.12	0.17	0.05	0.05	0.03	0	0.01	0	0.01	0.06
12.5	0.07	0	0	0.01	0.04	0	0.1	0.16	0.07	0.11	0.16	0.16	0.05	0	0	0.04	0.06
14.5	0.5	0.04	0.14	0.02	0.22	0.05	0.11	0.15	0.74	0.26	0.29	0.41	0.04	0.05	0.11	0.09	0.08
16.5	2.56	0.14	0.09	0.17	0.02	0.29	0.24	0.35	1.62	0.6	0.44	0.57	0.1	0.17	0.12	0.16	0.26
18.5	9.23	1.23	0.26	0.43	0.44	0.75	0.76	0.33	1.94	1.11	1.2	1.13	0.39	0.3	0.45	0.68	0.68
20.5	10.81	2.95	0.81	0.93	0.7	0.69	2.32	1.06	1.56	1.97	1.85	1.83	0.66	1.15	0.68	1.83	1.4
22.5	12.38	4.39	3.41	2.29	1.34	1.78	2.68	1.78	1.87	2.91	2.14	2.58	0.94	1.29	0.83	1.72	1.56
24.5	12.05	5.36	4.7	4.2	2.42	2.84	3.47	2.45	2.2	2.84	3.23	3.43	1.43	1.63	1.02	1.80	1.39
26.5	11.44	5.19	5.16	7.2	4.14	4.26	5.02	3.54	3.58	2.97	3.53	4.28	1.98	1.97	1.13	2.00	1.62
28.5	9.62	4.97	6.03	8	6.25	6.53	7.09	3.5	4.26	4.12	3.24	4.54	2.44	2.1	1.38	1.55	1.2
30.5	8.68	5.4	6.49	7.94	7.24	7.65	8.54	4.66	4.06	4.64	3.52	4.17	2.68	2.04	1.51	1.68	1.2
32.5	9.67	6.41	6.16	8.12	6.62	8.76	9.65	6.01	5.37	4.63	3.45	4.02	2.57	2.21	0.94	1.09	0.81
34.5	8.63	5.6	5.33	7.44	5.68	7.43	10.35	5.99	5.66	4.32	3.48	3.84	2.36	1.45	0.8	0.73	0.71
36.5	7.39	5.32	5.66	6.58	4.4	6.1	9.26	5.69	6.74	4.66	3.55	3.47	2.13	1.32	0.81	0.77	0.42
38.5	7.82	4.51	5.04	5.65	4.14	4.92	8.72	4.61	7.18	4.44	3.05	2.47	1.5	1.08	0.67	0.36	0.38
40.5	6.22	4.01	4.65	5.16	3.2	3.81	6.19	3.67	5.69	3.73	2.72	2.47	1.26	1.04	0.5	0.24	0.18
42.5	5.44	3.19	3.28	4.51	2.92	3.45	4.5	3.53	4.76	3.46	2.13	2.12	1.01	0.71	0.24	0.21	0.11
44.5	4.49	2.17	2.61	3.26	2.45	2.86	3.78	2.71	3.37	2.19	1.57	1.59	0.75	0.46	0.18	0.22	0.04
46.5	3.9	2.43	2.24	2.69	1.74	2.13	2.79	2.12	2.13	1.5	1.1	1.02	0.51	0.3	0.05	0.05	0.01
48.5	2.84	1.3	1.64	2.06	1.25	2.07	2.33	1.16	1.64	0.86	0.84	0.59	0.38	0.24	0.09	0.13	0.01
50.5	2.7	1.14	1.48	1.68	1.02	1.23	1.13	0.85	0.96	0.6	0.5	0.58	0.2	0.16	0.02	0.00	0.01
52.5	1.89	0.85	1.13	1.17	0.71	0.87	0.93	0.7	0.66	0.38	0.32	0.26	0.14	0.06	0.03	0.01	0
54.5	1.35	0.55	0.59	0.84	0.53	0.56	0.66	0.39	0.36	0.19	0.18	0.17	0.04	0.06	0.02	0	0
56.5	0.76	0.2	0.36	0.77	0.43	0.4	0.35	0.2	0.27	0.17	0.16	0.09	0.02	0.02	0	0	0
58.5	0.4	0.22	0.21	0.43	0.19	0.18	0.23	0.09	0.05	0.08	0.04	0.05	0.02	0	0.01	0	0
60.5	0.09	0.11	0.12	0.13	0.04	0.1	0.06	0.03	0	0.05	0.02	0.03	0.02	0	0	0	0
62.5	0.03	0	0.04	0.04	0.03	0.05	0.03	0.03	0.01	0.03	0.02	0.01	0	0	0	0	0
64.5	0.09	0	0.05	0.04	0	0.01	0.03	0	0	0	0	0	0	0	0	0	0
66.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
68.5	0	0	0	0.02	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 2a. Abundance (millions) at length of American plaice from fall surveys in Div. 2J. Data converted to Campelen equivalents.

Length/Year	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10.5	0	0	0	0	0	0	0	0.83	0	0.44	0	0	0	0	0	0	0
12.5	0	0	0	0	0	0.52	0	0.79	0	0.42	0	0.87	0	0	0	0	0
14.5	0.88	0.85	0	0.52	1.36	3.17	0.52	1.29	1.04	0.86	0	1.23	0.88	0	0	0	0.78
16.5	4.84	2.42	0	0.52	3.85	1.96	0.95	0.88	6.37	4.62	0.71	1.76	1.48	1.09	1.11	0	2.31
18.5	21.36	12.10	4.03	1.34	3.12	2.49	5.48	4.40	7.28	5.70	1.94	2.43	3.40	2.40	1.49	2.73	3.09
20.5	30.34	27.90	4.01	2.85	7.86	3.66	4.27	6.62	2.46	5.31	6.90	9.37	7.45	4.82	5.68	5.10	9.08
22.5	65.17	52.52	11.84	5.98	19.13	7.23	7.20	10.96	7.79	4.83	4.53	16.20	12.03	8.02	7.70	6.52	11.97
24.5	82.40	80.39	41.07	20.28	42.54	17.84	14.09	24.83	14.41	7.62	9.80	23.59	17.93	11.10	8.80	10.93	8.24
26.5	105.70	74.78	63.75	39.78	76.99	38.80	19.36	31.76	23.59	13.83	15.26	28.24	20.91	15.75	7.44	7.00	5.49
28.5	93.21	61.19	76.81	55.75	109.48	65.48	34.46	37.89	23.16	18.66	16.93	26.71	22.78	12.61	6.97	5.46	6.89
30.5	93.74	55.22	78.09	70.75	126.53	84.19	46.74	48.62	31.61	18.28	18.03	26.06	23.22	12.11	6.74	5.30	4.66
32.5	50.12	43.07	60.38	57.91	116.45	84.82	48.96	44.59	30.62	16.71	18.83	26.77	18.74	8.74	4.33	3.87	3.17
34.5	39.03	27.73	47.02	53.85	84.47	74.77	41.44	39.01	29.33	14.93	21.97	25.84	14.02	9.13	3.05	2.66	1.46
36.5	25.33	15.80	31.04	39.21	59.41	52.58	34.48	27.80	21.85	11.22	18.57	17.06	12.30	4.73	1.07	0.82	0.49
38.5	17.71	12.84	16.45	27.96	39.36	43.55	28.22	21.04	17.94	9.68	13.15	12.00	7.61	2.89	0.66	0.60	0.51
40.5	10.00	5.45	12.27	15.55	22.08	30.78	17.78	13.89	12.76	7.03	9.81	8.97	4.71	1.55	0.44	0.42	0.11
42.5	9.84	5.72	8.66	12.40	14.04	22.24	12.58	10.13	9.19	6.02	10.50	7.17	3.62	1.16	0.22	0.35	0.04
44.5	6.86	4.01	6.69	8.87	9.68	15.91	8.25	6.87	6.82	5.43	7.34	5.80	2.74	0.82	0.25	0.17	0.08
46.5	6.65	4.08	5.66	7.38	8.13	12.74	6.75	4.05	3.65	3.56	5.10	3.78	1.55	0.46	0.22	0.07	0.03
48.5	4.93	2.71	5.75	5.39	6.51	9.52	3.74	2.53	2.12	1.90	2.15	2.62	0.75	0.27	0.11	0	0
50.5	4.05	2.84	4.30	3.32	4.36	4.29	2.08	1.27	1.65	1.25	1.20	0.73	0.55	0.08	0.03	0	0
52.5	2.00	1.66	2.48	3.00	2.59	3.34	2.16	0.81	0.68	0.64	0.60	0.28	0.12	0.06	0.01	0	0
54.5	1.44	1.12	1.02	1.05	1.39	1.86	0.80	0.27	0.49	0.17	0.14	0.20	0	0.03	0	0	0
56.5	1.06	0.21	0.97	0.62	0.49	0.48	0.34	0.06	0.31	0.05	0.06	0.06	0.06	0	0	0	0
58.5	0.26	0.06	0.45	0.07	0.27	0.13	0.10	0.05	0.03	0.06	0	0.11	0.03	0	0	0	0
60.5	0.05	0	0.05	0.10	0	0.03	0	0	0	0	0	0	0	0	0	0	0
62.5	0	0	0.07	0	0.03	0	0	0	0	0	0	0	0	0	0	0	0

Table 2b. Abundance (millions) at length of American plaice from fall surveys in Div. 3K. Data converted to Campelen equivalents.

Length/Year	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8.5	0	0.62	0	0	0	0	0.35	5.53	0.80	0.45	0	0.87	0.66	0.14	0	0	1.07
10.5	0	0	0	0	0	0.40	0	3.42	5.00	1.33	1.49	0.76	0	0.32	0.14	0.23	1.61
12.5	2.13	0	0	0.42	1.29	0	3.07	4.84	2.05	3.15	4.57	4.61	1.43	0	0	1.14	1.58
14.5	14.63	1.05	4.00	0.51	6.51	1.38	3.10	4.40	21.84	7.60	8.45	12.16	1.20	1.35	3.19	2.66	2.38
16.5	75.64	4.14	2.58	4.99	0.66	8.55	7.13	10.34	47.93	17.54	12.97	16.78	3.06	4.93	3.45	4.82	7.64
18.5	192.04	25.36	5.65	8.82	9.04	15.37	15.50	6.81	40.44	22.74	24.72	23.22	7.98	6.16	9.21	13.86	13.79
20.5	165.05	44.49	12.20	13.88	10.44	10.43	34.90	15.89	23.49	29.91	27.99	27.65	9.76	17.16	10.14	27.54	20.96
22.5	142.43	50.73	39.26	26.17	15.24	20.46	30.58	20.28	21.29	33.23	24.45	29.32	10.63	14.69	9.34	19.67	17.76
24.5	107.74	48.14	42.53	37.86	22.04	25.76	31.32	22.14	19.96	25.80	29.26	31.01	12.97	14.81	9.29	16.34	12.57
26.5	81.33	37.20	37.28	51.42	29.87	30.76	36.17	25.53	25.79	21.53	25.61	30.83	14.31	14.39	8.28	14.46	11.73
28.5	53.88	27.71	33.72	44.65	34.68	36.32	39.75	19.38	23.66	22.78	17.89	25.22	13.60	11.59	7.59	8.52	6.62
30.5	40.97	25.99	31.16	37.62	34.62	36.38	40.70	22.62	19.62	22.53	17.20	20.07	13.13	10.26	7.68	8.50	6.11
32.5	36.86	24.20	23.07	30.61	24.62	33.03	36.40	22.43	20.11	17.22	12.76	15.06	9.63	8.19	3.44	4.01	3.01
34.5	28.41	18.60	17.75	24.74	19.00	24.62	34.23	20.14	19.01	14.80	11.90	12.91	8.04	5.10	2.77	2.61	2.50
36.5	19.27	13.69	14.53	16.87	11.04	15.55	24.05	14.40	17.32	11.51	8.60	8.62	5.14	3.16	1.78	1.88	0.86
38.5	18.49	10.57	11.78	13.23	9.66	11.49	20.47	10.66	17.00	10.31	7.06	5.77	3.43	2.41	1.52	0.79	0.78
40.5	11.41	7.37	8.54	9.43	5.90	7.00	11.32	6.74	10.41	6.84	4.96	4.52	2.30	1.92	0.91	0.43	0.32
42.5	9.97	5.82	6.05	8.26	5.35	6.31	8.23	6.50	8.70	6.35	3.90	3.88	1.85	1.31	0.44	0.39	0.21
44.5	8.22	3.95	4.81	6.03	4.51	5.22	6.92	4.97	6.15	4.02	2.88	2.91	1.38	0.84	0.33	0.40	0.06
46.5	7.14	4.46	4.14	5.30	3.19	3.90	5.10	3.87	3.93	2.75	2.00	1.88	0.94	0.55	0.10	0.10	0.01
48.5	5.20	2.38	3.03	3.78	2.29	3.79	4.26	2.16	3.00	1.57	1.53	1.06	0.70	0.44	0.17	0.23	0.02
50.5	4.95	2.07	2.74	3.06	1.89	2.24	2.07	1.55	1.77	1.10	0.93	1.07	0.37	0.29	0.03	0	0.03
52.5	3.46	1.56	2.08	2.13	1.30	1.60	1.70	1.27	1.22	0.70	0.58	0.48	0.26	0.11	0.06	0.01	0
54.5	2.47	1.01	1.10	1.56	1.16	1.03	1.22	0.72	0.66	0.34	0.33	0.31	0.07	0.10	0.03	0	0
56.5	1.40	0.37	0.67	1.41	0.79	0.74	0.64	0.37	0.50	0.32	0.29	0.17	0.03	0.03	0	0	0
58.5	0.74	0.39	0.39	0.79	0.35	0.33	0.42	0.17	0.10	0.14	0.07	0.09	0.03	0	0.01	0	0
60.5	0.17	0.21	0.23	0.23	0.08	0.18	0.15	0.05	0	0.08	0.04	0.06	0.03	0	0	0	0
62.5	0.06	0	0.06	0.07	0.06	0.06	0.06	0.05	0.01	0.06	0.04	0.03	0	0	0	0	0
64.5	0.17	0	0.09	0.06	0	0.03	0.06	0	0	0	0	0	0	0	0	0	0
66.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
68.5	0	0	0	0.04	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 3a. Mean number per tow of American plaice, at age, from fall surveys in Div. 2J. Data in original Engel units.

Age/Year	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0.01	0.01	0	0	0.01	0	0.01	0	0.02	0	0	0	0	0
3	0	0.02	0	0	0.01	0.12	0.04	0	0.04	0.08	0.06	0	0.07	0.04	0.06	0	0	v
4	0.15	0.42	0.24	0.05	0.59	0.27	0.61	0.25	0.12	0.19	0.32	0.14	0.36	0.16	0.19	0.07	0.12	0.20
5	6.45	3.90	1.67	0.50	2.48	2.72	1.34	0.97	1.20	0.98	0.48	0.99	1.81	0.64	1.04	0.43	0.38	0.29
6	13.26	11.85	7.17	4.14	15.39	7.63	7.37	3.33	4.72	3.75	3.31	2.83	5.73	3.16	2.39	1.01	1.26	0.86
7	26.07	18.06	12.90	21.00	21.17	23.30	22.94	11.67	11.08	9.03	4.80	5.10	6.25	5.27	2.72	1.68	1.21	1.46
8	36.56	15.16	13.38	16.55	16.69	27.03	29.48	16.85	13.89	9.85	5.85	7.86	7.93	4.30	2.71	1.10	1.17	1.04
9	20.86	11.53	8.08	10.00	6.48	27.23	17.00	13.52	12.60	9.55	4.46	7.40	7.32	4.26	1.29	0.49	0.35	0.30
10	9.64	7.30	4.47	6.64	4.35	12.03	12.20	5.79	4.35	4.13	3.15	4.49	3.27	3.17	0.48	0.22	0.24	0.11
11	6.14	4.10	2.02	3.68	1.56	4.80	6.28	3.00	1.63	1.05	0.89	1.59	2.00	0.94	0.23	0.14	0.07	0.01
12	4.24	3.29	2.69	3.37	0.63	2.95	1.79	0.98	1.02	0.83	0.55	0.57	0.70	0.59	0.08	0.00	0.01	0
13	2.80	2.76	1.60	1.50	0.05	1.80	1.16	0.82	0.50	0.33	0.20	0.23	0.16	0.20	0.03	0.01	0	0
14	1.59	1.27	0.47	0.89	0	0.80	0.30	0.15	0.08	0.07	0.05	0.02	0.03	0.02	0	0.01	0	0
15	0.66	0.91	0.12	0.26	0	0.16	0.11	0.06	0.00	0.03	0.01	0	0.04	0.01	0	0	0	0
16	0	0.43	0.05	0.11	0	0.08	0	0	0	0	0	0	0	0.02	0	0	0	0
17	0	0.15	0	0.04	0	0.01	0.01	0	0	0	0	0	0	0	0	0	0	0
18	0	0.01	0	0.02	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19	0	0.01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 3b. Mean nunmber per tow of American plaice, at age, from fall surveys in Div. 3K. Data in original Engel units.

Age/Year	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
1	0	0.01	0	0	0	0	0.01	0	0.02	0.02	0.01	0	0.01	0	0	0	0
2	0	0	0.01	0	0.02	0.01	0.06	0.16	0.08	0.03	0.16	0.07	0	0.01	0	0	0.05
3	0.19	0.01	0.07	0.12	0.24	0.44	0.14	0.19	1.21	0.39	0.32	0.47	0.09	0.02	0.06	0.09	0.04
4	3.20	0.32	0.10	0.18	0.43	0.61	1.44	0.60	1.79	1.96	0.80	0.96	0.34	0.45	0.15	0.33	0.22
5	8.19	1.87	0.97	0.85	0.93	2.28	2.02	1.74	2.14	2.18	3.36	1.51	0.88	1.08	0.50	1.11	0.40
6	12.05	4.10	3.28	1.82	2.29	4.19	5.76	2.52	4.05	3.47	2.87	4.07	1.54	1.69	1.15	1.93	0.86
7	10.83	5.58	8.43	6.37	4.46	7.26	5.95	4.66	4.25	3.90	2.92	3.81	2.39	1.87	1.19	1.20	1.92
8	8.01	6.08	5.93	9.08	5.97	7.46	10.57	5.21	5.35	3.99	3.08	2.42	1.80	1.28	0.83	0.96	0.99
9	6.89	4.95	4.33	5.23	4.88	3.07	5.91	4.08	4.68	3.59	2.41	2.90	1.40	1.12	0.60	0.38	0.44
10	5.76	3.60	3.67	5.60	2.54	2.38	2.85	2.04	2.37	1.38	1.31	1.56	0.74	0.55	0.30	0.24	0.19
11	3.45	1.68	2.14	1.75	1.69	0.87	1.72	0.91	0.99	0.66	0.56	0.79	0.42	0.15	0.06	0.13	0.05
12	2.96	2.14	1.71	2.36	0.82	0.91	1.18	0.97	0.79	0.43	0.29	0.53	0.19	0.10	0.05	0.06	0.01
13	2.57	1.07	0.84	1.13	0.67	0.43	0.57	0.48	0.37	0.16	0.15	0.21	0.14	0.04	0.02	0	0
14	1.33	0.35	0.54	0.48	0.33	0.23	0.25	0.10	0.15	0.11	0.10	0.08	0.01	0.03	0.01	0	0
15	1.04	0.14	0.21	0.29	0.17	0.09	0.17	0.07	0.04	0.07	0.02	0.04	0.02	0	0.01	0	0
16	0.53	0.12	0.08	0.20	0.05	0.02	0.04	0.03	0.00	0.03	0	0.01	0	0	0	0	0
17	0.20	0.01	0.04	0.00	0.04	0	0.02	0	0	0	0	0	0	0	0	0	0
18	0.06	0.02	0.02	0.03	0.01	0	0	0	0	0	0	0	0	0	0	0	0
19	0.01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 4a. Mean number per tow of American plaice, at age, from fall surveys in Div. 2J. Data converted to Campelen equivalents.

Age/Year	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0.16	0.13	0	0	0.25	0	0.14	0	0.27	0	0	0	0	0
3	0.40	0	0	0.16	1.71	0.42	0	0.64	2.82	0.88	0	0.92	0.49	0.71	0	0	0
4	6.34	3.08	0.72	3.34	2.07	4.46	2.47	0.98	2.49	3.52	1.26	2.62	1.54	1.27	0.78	1.04	1.61
5	30.2	15.48	4.04	10.36	14.14	6.34	5.80	7.63	5.48	3.14	5.55	9.22	3.96	5.24	2.91	2.45	2.16
6	64.82	43.65	20.61	41.02	27.20	23.62	12.89	17.95	13.85	11.28	9.80	20.74	13.08	8.94	4.7	5.7	5.27
7	78.74	54.69	72.78	41.35	61.20	54.16	29.36	28.80	20.64	10.96	12.33	15.45	14.91	6.82	5.34	3.91	5.64
8	42.75	38.96	42.02	24.47	56.26	47.33	29.83	25.01	15.66	8.84	12.75	13.85	8.66	4.64	2.38	2.55	2.58
9	30.28	16.48	17.92	6.86	44.77	20.41	16.96	15.82	10.95	5.02	8.72	9.01	6.31	1.57	0.76	0.49	0.48
10	12.55	6.69	8.96	4.39	15.33	12.57	6.05	4.33	4.06	3.03	4.57	3.33	3.60	0.48	0.24	0.25	0.11
11	5.93	2.56	4.49	1.58	4.92	6.20	3.06	1.62	1.05	0.89	1.62	2.00	0.94	0.23	0.14	0.07	0.01
12	4.34	3.15	3.86	0.63	2.97	1.77	1.01	1.02	0.88	0.54	0.58	0.70	0.59	0.08	0.06	0.01	0
13	3.58	1.84	1.69	0.05	1.83	1.13	0.84	0.49	0.38	0.21	0.23	0.16	0.20	0.03	0.01	0	0
14	1.64	0.55	1.00	0	0.80	0.29	0.15	0.06	0.06	0.05	0.02	0.03	0.02	0	0	0	0
15	1.17	0.14	0.30	0	0.15	0.11	0.06	0	0.03	0.01	0	0.04	0.01	0	0	0	0
16	0.56	0.06	0.13	0	0.06	0	0	0	0	0	0	0	0.02	0	0	0	0
17	0.19	0	0.05	0	0.02	0.01	0	0	0	0	0	0	0	0	0	0	0
18	0.01	0	0.02	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19	0.01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 4b. Mean number per tow of American plaice, at age, from fall surveys in Div. 3K. Data converted to Campelen equivalents.

Age/Year	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
1	0	0.20	0	0	0	0	0.06	0	0.20	0.21	0.13	0	0.15	0	0	0	0
2	0	0	0.22	0	0.17	0.11	1.02	2.47	1.14	0.57	2.64	1.15	0	0.16	0.02	0	0.73
3	3.22	0.18	1.26	1.54	3.31	5.90	1.67	2.62	16.99	4.98	4.21	6.60	1.19	0.36	0.94	1.08	0.58
4	50.56	4.25	1.32	1.92	3.74	5.40	11.77	4.69	16.32	15.49	7.16	10.00	2.82	3.64	1.28	3.20	2.13
5	84.34	18.61	8.30	6.09	5.56	12.07	11.91	9.86	10.87	10.92	20.76	10.47	4.88	6.98	4.07	8.21	3.71
6	85.28	27.85	19.45	10.15	9.74	16.00	22.33	10.25	13.84	11.58	10.40	17.84	6.29	6.95	5.40	9.55	5.91
7	51.67	24.97	32.64	23.53	14.35	19.17	14.40	12.01	10.22	9.39	6.95	11.27	6.52	5.08	3.84	3.98	9.08
8	21.15	17.46	15.97	23.32	13.94	13.39	18.03	8.24	9.27	6.51	4.83	4.74	3.14	2.42	1.63	2.16	2.70
9	16.56	9.84	7.63	9.12	8.17	4.02	6.96	4.75	5.23	4.25	2.85	4.13	1.82	1.32	0.81	0.63	0.70
10	9.10	5.26	4.98	7.70	3.39	2.72	2.92	2.02	2.96	1.61	1.39	1.71	0.76	0.55	0.32	0.27	0.26
11	4.75	2.15	2.71	1.93	1.90	1.00	1.69	0.85	1.16	0.71	0.59	0.85	0.42	0.15	0.05	0.13	0.05
12	3.76	2.63	2.11	2.61	0.92	1.08	1.10	0.91	0.78	0.46	0.32	0.57	0.19	0.10	0.05	0.06	0.01
13	3.23	1.32	1.04	1.25	0.74	0.50	0.53	0.44	0.37	0.17	0.16	0.23	0.14	0.04	0.02	0	0
14	1.67	0.43	0.67	0.53	0.37	0.26	0.23	0.11	0.14	0.10	0.11	0.09	0.01	0.03	0.01	0	0
15	1.30	0.17	0.27	0.33	0.20	0.10	0.15	0.07	0.04	0.06	0.02	0.04	0.02	0	0	0	0
16	0.67	0.15	0.10	0.23	0.06	0.02	0.04	0.02	0	0.02	0	0.01	0	0	0	0	0
17	0.25	0.01	0.05	0	0.04	0	0.01	0	0	0	0.01	0	0	0	0	0	0
18	0.08	0.03	0.03	0.03	0	0	0	0	0	0	0	0	0	0	0	0	0
19	0.01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 5. Length weight relationships used in the calculation of biomass. The equation is: weight = (10**alpha)*(length**beta)

Division	Year	Sex	Alpha	Beta
2J	1978-1989	male	-5.30924	3.152371
		female	-5.469299	3.265173
	1990	male	-5.356495	3.194091
		female	-5.435227	3.254803
	1991	male	-5.132591	3.027173
		female	-5.426405	3.23093
	1992	male	-5.194974	3.05988
		female	-5.463617	3.248894
	1993	male	-5.107612	3.001711
		female	-5.358942	3.185593
	1994	male	-5.308611	3.135771
		female	-5.313787	3.159741
3K	1978-1989	male	-5.349366	3.173859
		female	-5.485211	3.269289
	1990	male	-5.362486	3.184037
		female	-5.48321	3.269736
	1991	male	-5.30331	3.143347
		female	-5.416403	3.222213
	1992	male	-5.303696	3.139278
		female	-5.47223	3.260596
	1993	male	-5.442397	3.237749
		female	-5.586394	3.33653
	1994	male	-5.376129	3.186482
		female	-5.495869	3.277097

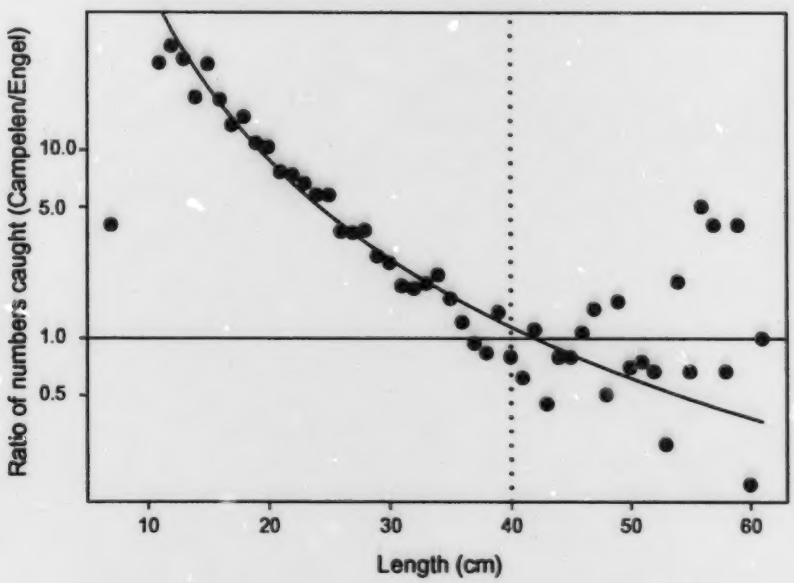


Figure 1. Ratios of Campelen catch to Engel catch, by length group, from comparative fishing trials between the 2 gears on the *Teleost* and *Gadus Atlantica*. The dots are the observed ratios and the curve is the fitted line. The solid horizontal line is the 1:1 line. The dotted vertical line marks 40 cm.

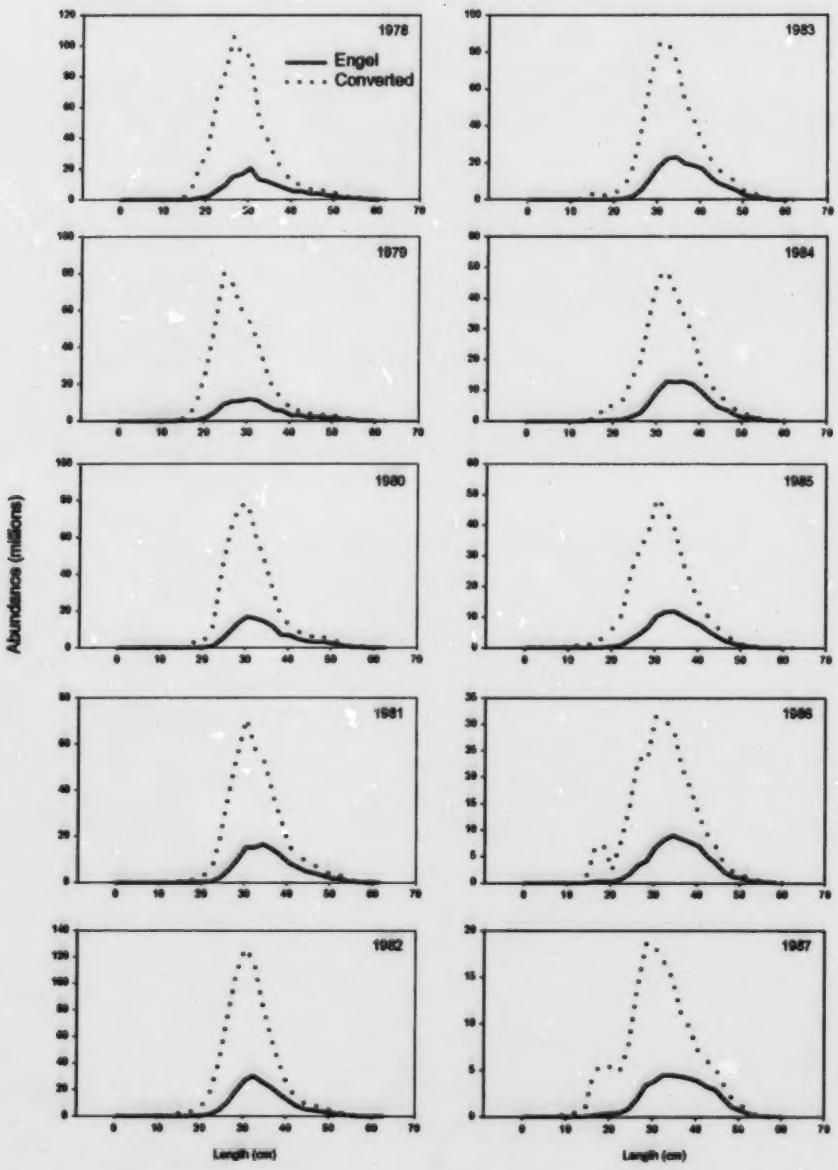


Figure 2. Abundance at length from 1978 to 1994 for converted and original Engel data for Div. 2J.

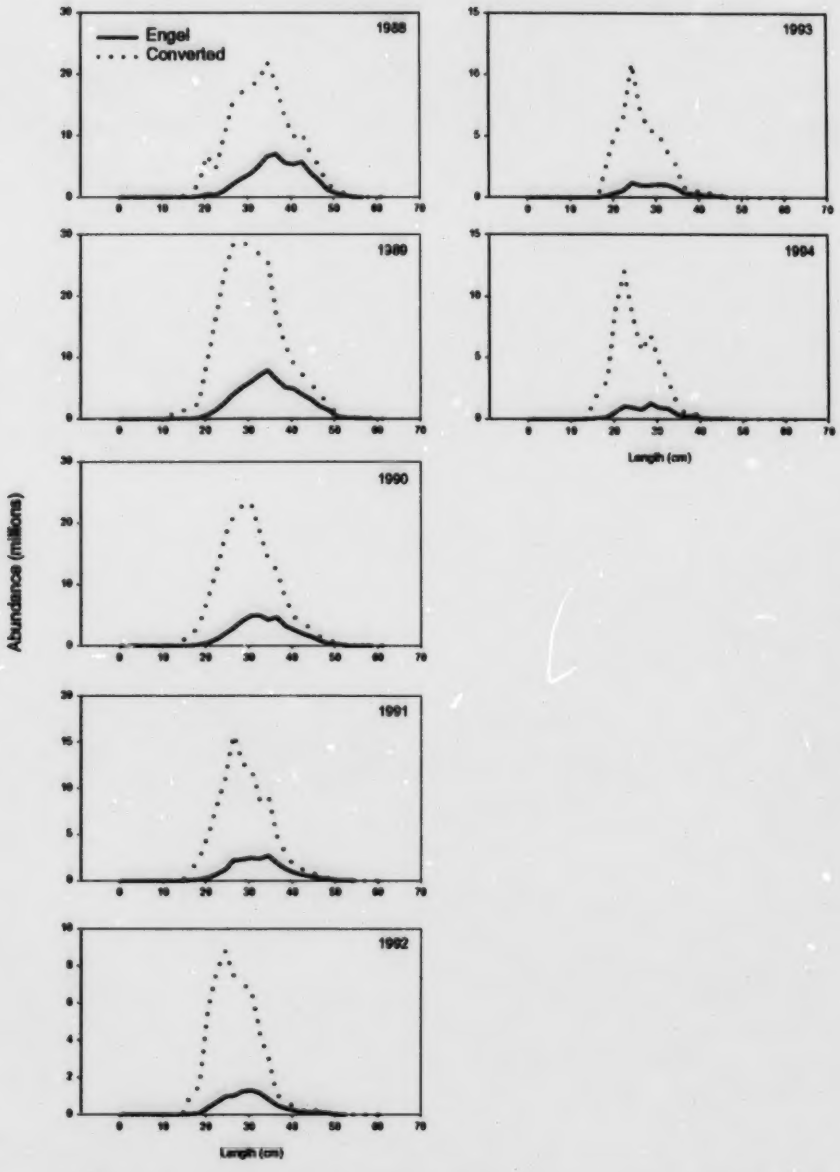


Figure 2 Cont'd. Abundance at length from 1978 to 1994 for converted and original Engel data for Div. 2J.

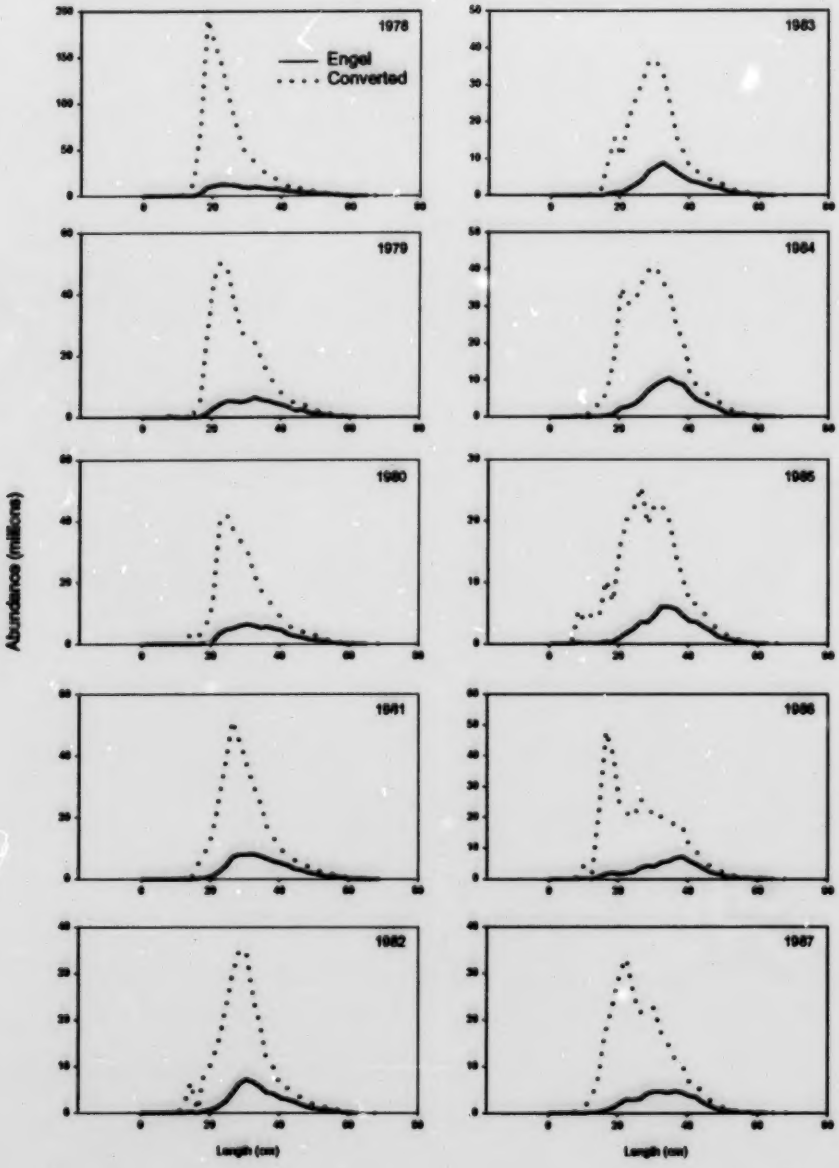


Figure 3. Abundance at length from 1978 to 1994 for converted and original Engel data for Div. 3K.

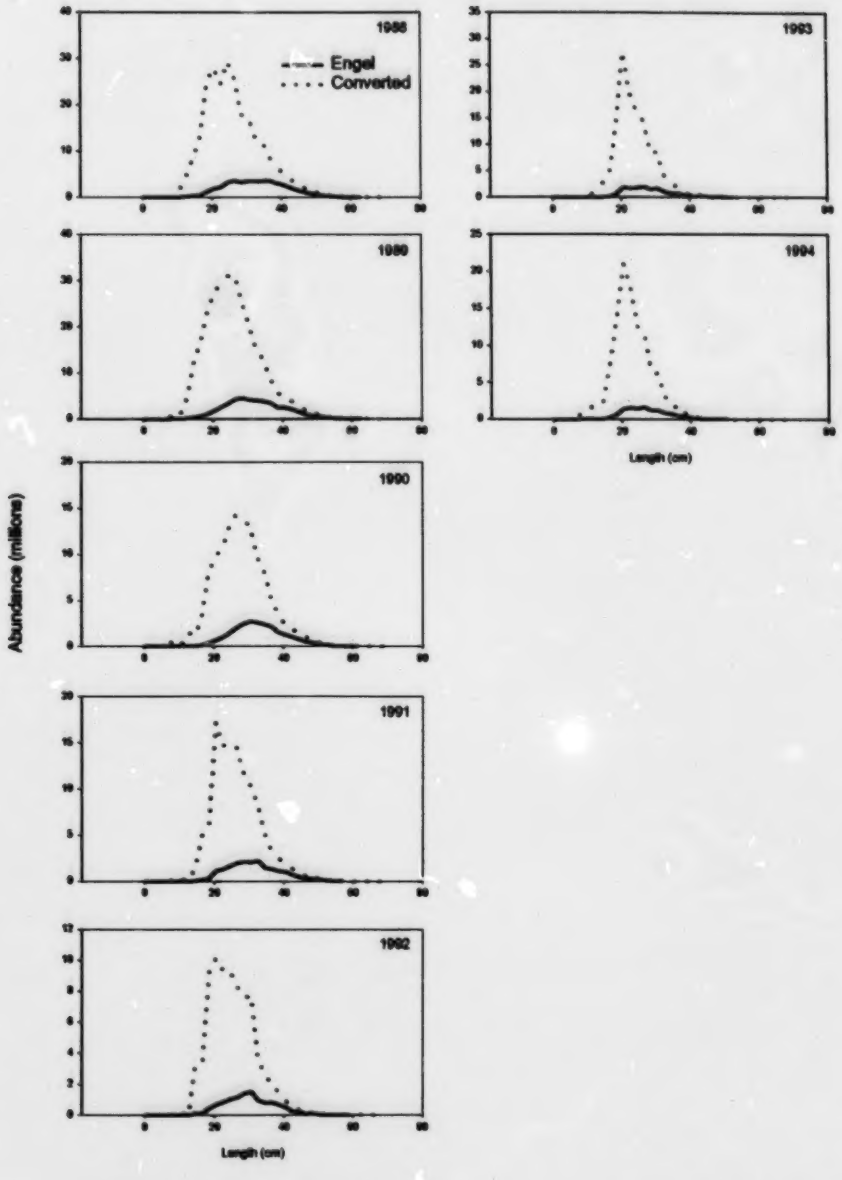


Figure 3 Cont'd. Abundance at length from 1978 to 1994 for converted and original Engel data for Div. 3K.

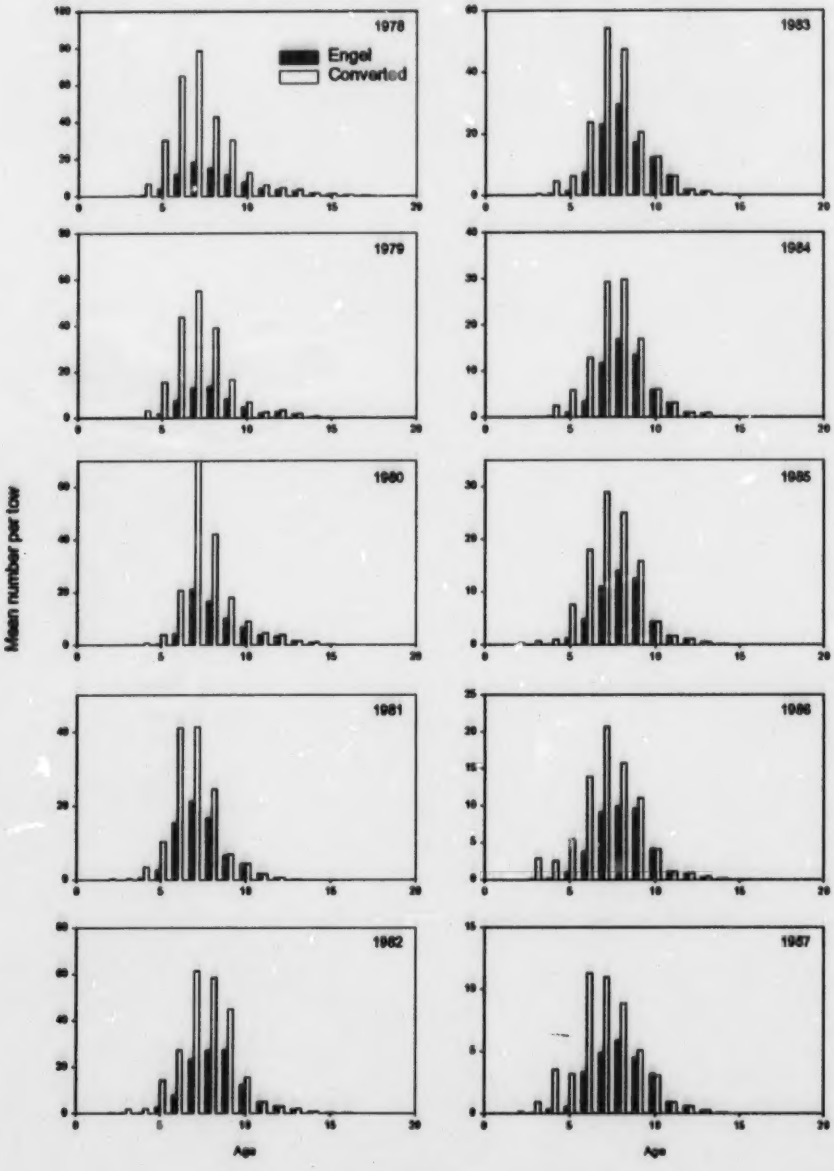


Figure 4. Mean number per tow at age from 1978 to 1994 for converted and original Engel data for Div. 2J.

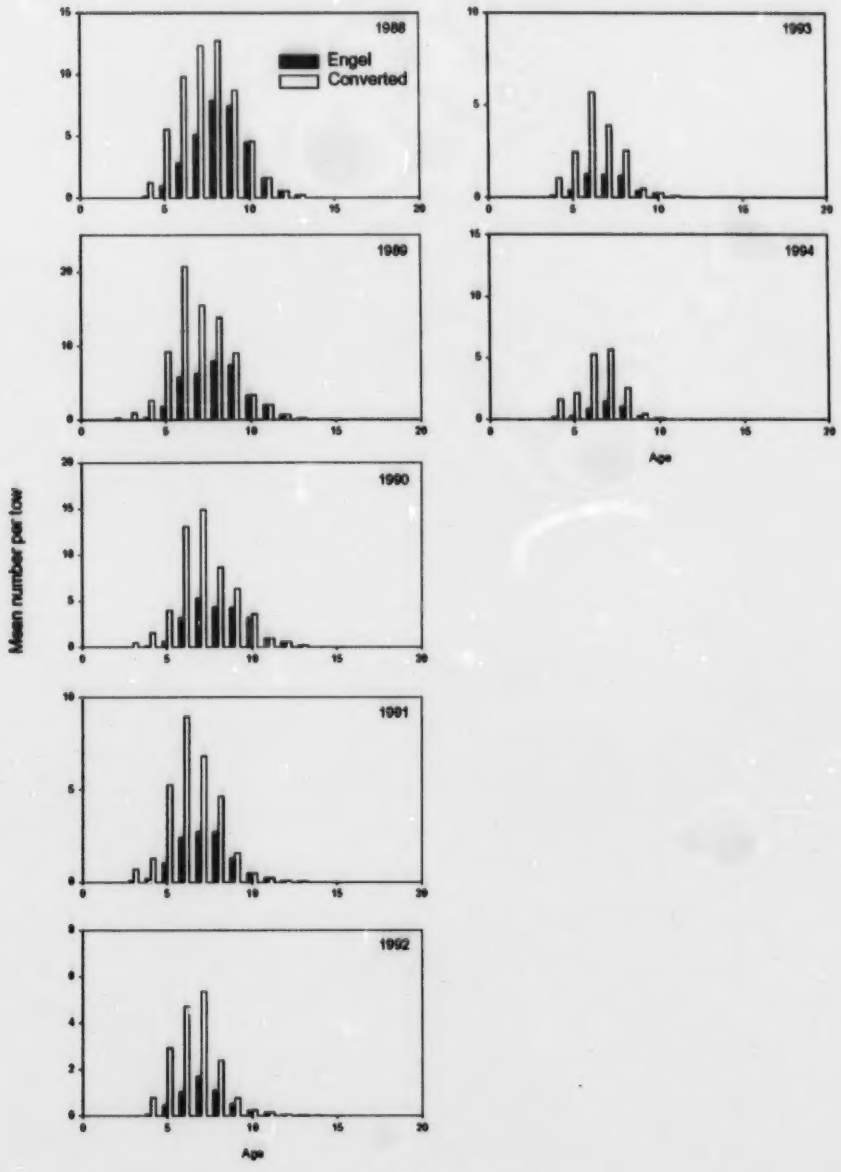


Figure 4 Cont'd. Mean number per tow at age from 1978 to 1994 for converted and original Engel data for Div. 2J.

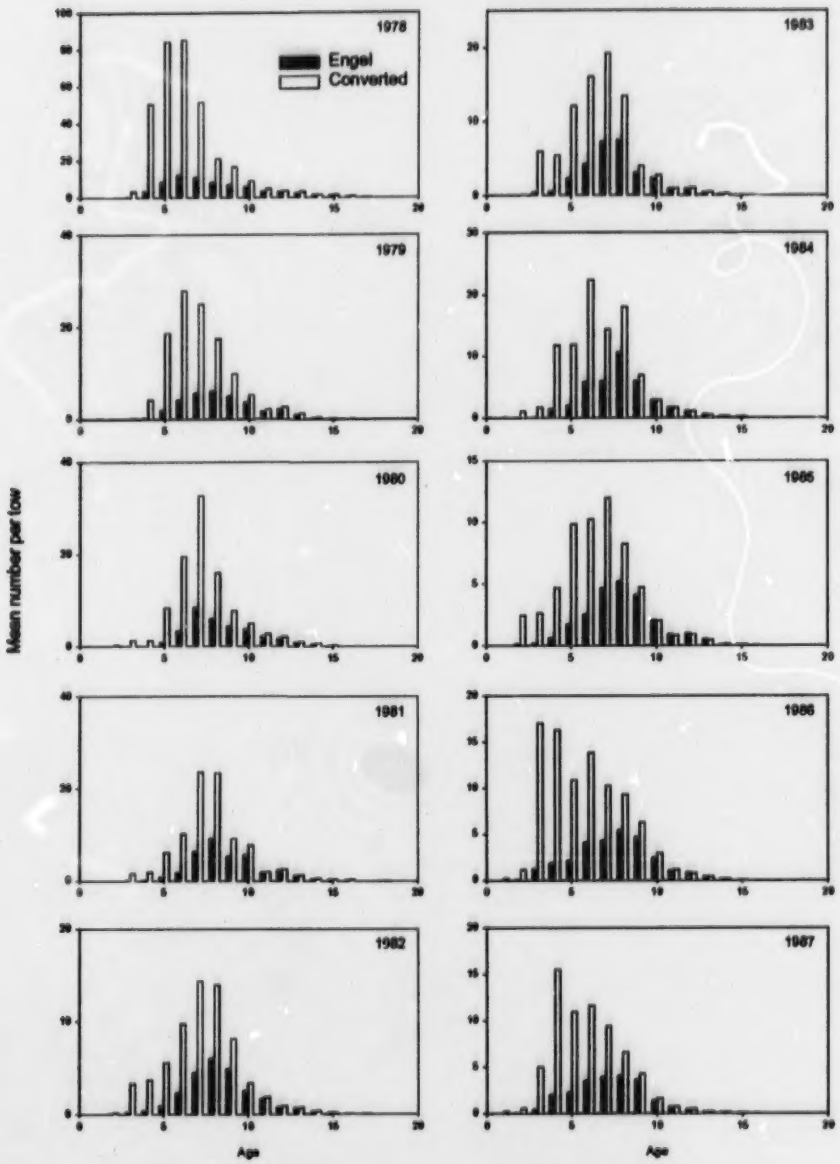


Figure 5. Mean number per tow at age from 1978 to 1994 for converted and original Engel data for Div. 3K.

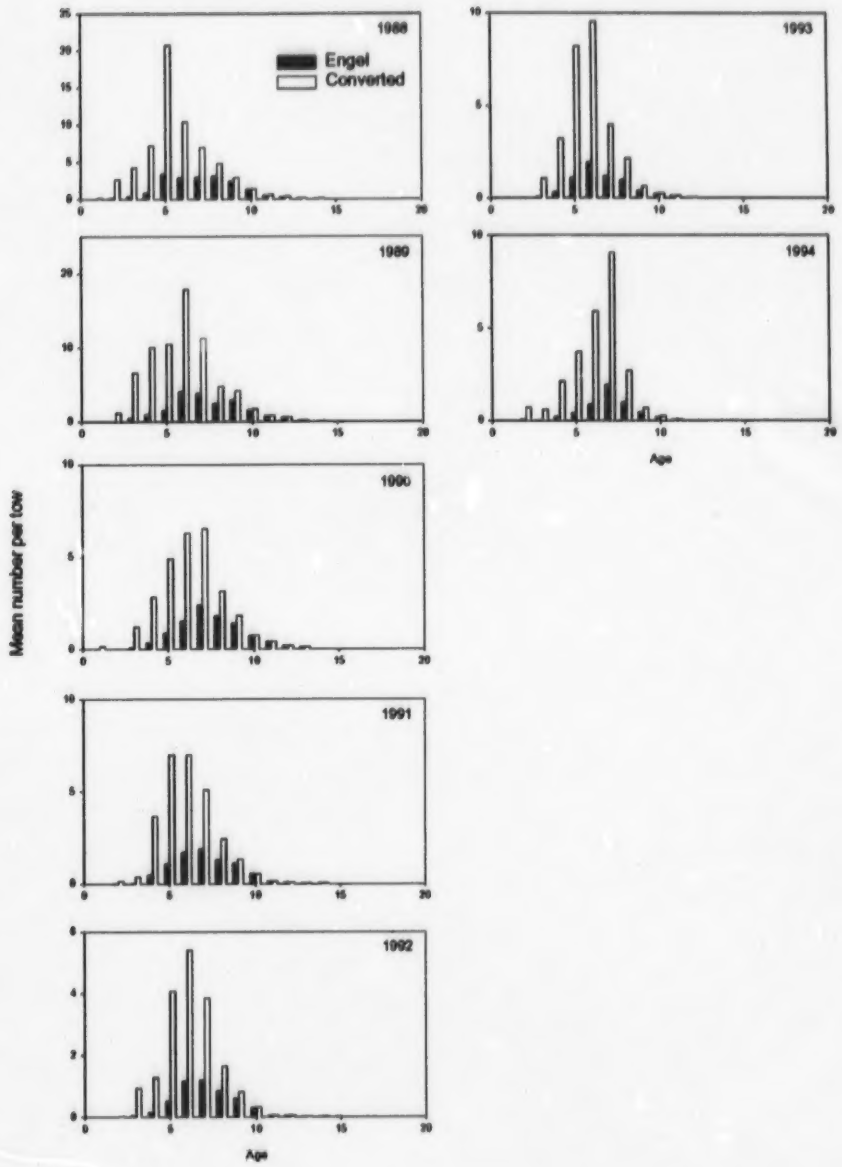
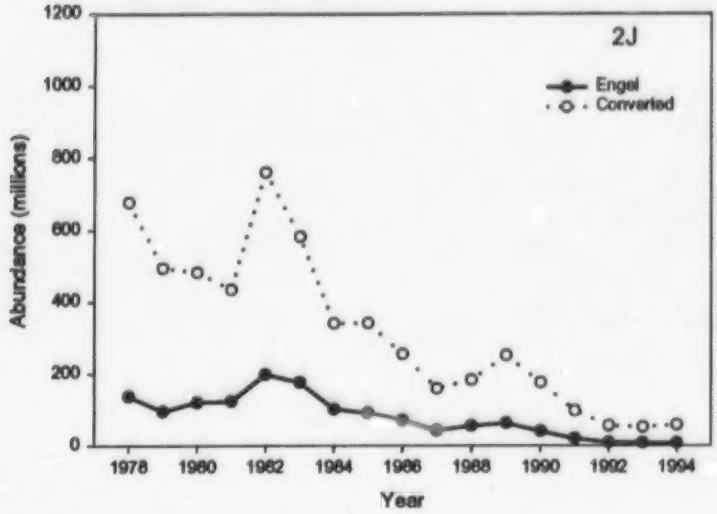


Figure 5 Cont'd. Mean number per tow at age from 1978 to 1994 for converted and original Engel data for Div. 3K.



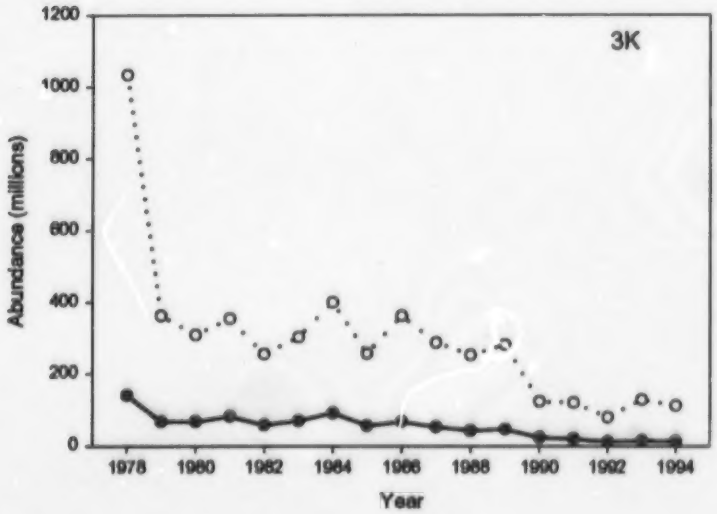


Figure 6. Abundance (millions) of American plaice in Div. 2J and 3K in original Engel data and converted to Campelen equivalents.

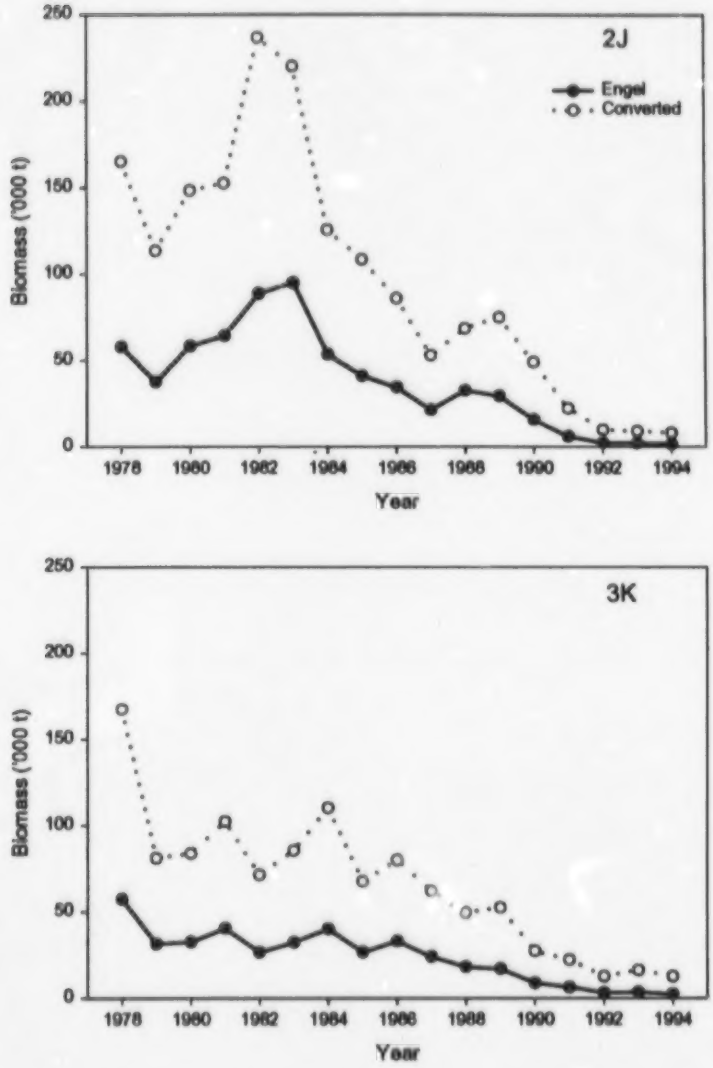


Figure 7. Biomass ('000 t) of American plaice in Div. 2J and 3K in original Engel data and converted to Campelen equivalents.